investigating a Dataset Project

January 4, 2021

1 Project: Data Analysis of 187 Countries with respect to life expectancy, income, and children per woman.

1.1 Table of Contents

1.1.1

1.2 Introduction

> In this project we will analyzing data associated with information of people around the world accross 240 years. In particular we will be looking at trends related to 3 indicators that are income, life expectancy, and children per woman.

In the end we will answer two question:

Question 1: What are the effects of income on life expectancy and children per woman?

Question 2: How has income, life expectancy, and children per woman changes throught the years?

[104]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

Data Wrangling

3 indicators where chosen from Gapminder World.

The indicators are : 1-life_expectancy_years

2-income_per_person_gdppercapita_ppp_inflation_adjusted

3-children_per_woman_total_fertility

The data will be loaded and checked for cleanliness.

1.2.1 General Properties

[105]:
```
lifeex_df = pd.read_csv('life_expectancy_years.csv')
income_df = pd.read_csv('income_per_person_gdppercapita_ppp_inflation_adjusted.
↪csv')
children_df = pd.read_csv('children_per_woman_total_fertility.csv')
```

Here we loaded all the dataframes.

[106]:
```
lifeex_df.head()
```

[106]:
```
       country  1800  1801  1802  1803  1804  1805  1806  1807  1808  … \
0  Afghanistan  28.2  28.2  28.2  28.2  28.2  28.2  28.1  28.1  28.1  …
1      Albania  35.4  35.4  35.4  35.4  35.4  35.4  35.4  35.4  35.4  …
2      Algeria  28.8  28.8  28.8  28.8  28.8  28.8  28.8  28.8  28.8  …
3      Andorra   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN  …
4       Angola  27.0  27.0  27.0  27.0  27.0  27.0  27.0  27.0  27.0  …

   2091  2092  2093  2094  2095  2096  2097  2098  2099  2100
0  76.5  76.6  76.7  76.9  77.0  77.1  77.3  77.4  77.5  77.7
1  87.4  87.5  87.6  87.7  87.8  87.9  88.0  88.1  88.2  88.3
2  88.3  88.4  88.5  88.6  88.7  88.8  88.9  89.0  89.1  89.2
3   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN   NaN
4  78.7  78.9  79.0  79.1  79.3  79.4  79.5  79.7  79.8  79.9

[5 rows x 302 columns]
```

We printed the first 5 lines of the first dataframe. Notice Andorra has null values(empty values) we will clean it in the next steps.

[107]:
```
lifeex_df.describe()
```

[107]:
```
             1800        1801        1802        1803        1804        1805  \
count  184.000000  184.000000  184.000000  184.000000  184.000000  184.000000
mean    31.502717   31.461957   31.478804   31.383152   31.459239   31.586413
std      3.814689    3.806303    3.938674    3.962376    3.934674    4.010884
min     23.400000   23.400000   23.400000   19.600000   23.400000   23.400000
25%     29.075000   28.975000   28.900000   28.900000   28.975000   29.075000
50%     31.750000   31.650000   31.550000   31.500000   31.550000   31.650000
75%     33.825000   33.900000   33.825000   33.625000   33.725000   33.825000
max     42.900000   40.300000   44.400000   44.800000   42.800000   44.300000

             1806        1807        1808        1809  …        2091  \
count  184.000000  184.000000  184.000000  184.000000  …  184.000000
mean    31.644565   31.598370   31.383152   31.310326  …   83.758152
std      4.110598    3.981247    4.087872    4.040580  …    5.600794
min     23.400000   23.400000   12.500000   13.400000  …   67.100000
25%     29.075000   29.075000   28.975000   28.875000  …   79.500000
50%     31.750000   31.750000   31.550000   31.500000  …   84.200000
```

```
75%     33.925000   33.925000   33.725000   33.625000  …   88.125000
max     45.800000   43.600000   43.500000   41.700000  …   93.700000

            2092        2093        2094        2095        2096        2097  \
count  184.00000  184.000000  184.000000  184.000000  184.000000  184.000000
mean    83.87663   83.996196   84.119022   84.236957   84.358152   84.478804
std      5.59444    5.589074    5.577601    5.570850    5.566060    5.556903
min     67.30000   67.400000   67.500000   67.600000   67.700000   67.800000
25%     79.70000   79.800000   79.900000   80.075000   80.200000   80.375000
50%     84.35000   84.450000   84.550000   84.650000   84.750000   84.850000
75%     88.22500   88.325000   88.500000   88.600000   88.700000   88.800000
max     93.90000   94.000000   94.100000   94.200000   94.300000   94.400000

            2098       2099        2100
count  184.000000  184.00000  184.000000
mean    84.593478   84.71087   84.829891
std      5.550234    5.54055    5.532609
min     67.900000   68.00000   68.100000
25%     80.475000   80.57500   80.775000
50%     85.000000   85.15000   85.250000
75%     88.900000   89.00000   89.100000
max     94.500000   94.70000   94.800000

[8 rows x 301 columns]
```

[108]:
```
lifeex_df.fillna(lifeex_df.mean(), inplace=True)
```

Here we cleaned the dataframe by replacing null values with the mean for each year. This was done to allow us to use the data from the other dataframes such as income and children per woman without having null vales for life expectancy.

[109]:
```
lifeex_df.head()
```

[109]:
```
       country       1800       1801       1802       1803       1804  \
0  Afghanistan  28.200000  28.200000  28.200000  28.200000  28.200000
1      Albania  35.400000  35.400000  35.400000  35.400000  35.400000
2      Algeria  28.800000  28.800000  28.800000  28.800000  28.800000
3      Andorra  31.502717  31.461957  31.478804  31.383152  31.459239
4       Angola  27.000000  27.000000  27.000000  27.000000  27.000000

        1805       1806      1807       1808  …       2091      2092  \
0  28.200000  28.100000  28.10000  28.100000  …  76.500000  76.60000
1  35.400000  35.400000  35.40000  35.400000  …  87.400000  87.50000
2  28.800000  28.800000  28.80000  28.800000  …  88.300000  88.40000
3  31.586413  31.644565  31.59837  31.383152  …  83.758152  83.87663
4  27.000000  27.000000  27.00000  27.000000  …  78.700000  78.90000

        2093       2094       2095       2096       2097       2098      2099  \
```

```
0  76.700000  76.900000  77.000000  77.100000  77.300000  77.400000  77.50000
1  87.600000  87.700000  87.800000  87.900000  88.000000  88.100000  88.20000
2  88.500000  88.600000  88.700000  88.800000  88.900000  89.000000  89.10000
3  83.996196  84.119022  84.236957  84.358152  84.478804  84.593478  84.71087
4  79.000000  79.100000  79.300000  79.400000  79.500000  79.700000  79.80000

        2100
0  77.700000
1  88.300000
2  89.200000
3  84.829891
4  79.900000

[5 rows x 302 columns]
```

Now we see that for the country of Andorra the values have been replaced.

[110]:
```
income_df.head()
```

[110]:
```
       country  1800  1801  1802  1803  1804  1805  1806  1807  1808  … \
0  Afghanistan   603   603   603   603   603   603   603   603   603  …
1      Albania   667   667   667   667   667   668   668   668   668  …
2      Algeria   715   716   717   718   719   720   721   722   723  …
3      Andorra  1200  1200  1200  1200  1210  1210  1210  1210  1220  …
4       Angola   618   620   623   626   628   631   634   637   640  …

    2031   2032   2033   2034   2035   2036   2037   2038   2039   2040
0   2550   2600   2660   2710   2770   2820   2880   2940   3000   3060
1  19400  19800  20200  20600  21000  21500  21900  22300  22800  23300
2  14300  14600  14900  15200  15500  15800  16100  16500  16800  17100
3  73600  75100  76700  78300  79900  81500  83100  84800  86500  88300
4   6110   6230   6350   6480   6610   6750   6880   7020   7170   7310

[5 rows x 242 columns]
```

We printed the first 5 lines of the second dataframe.

[111]:
```
income_df.describe()
```

[111]:
```
              1800         1801         1802         1803         1804  \
count   193.000000   193.000000   193.000000   193.000000   193.000000
mean    978.523316   978.948187   980.725389   980.922280   981.911917
std     579.633227   579.915248   582.565512   582.032626   583.963199
min     250.000000   250.000000   249.000000   249.000000   249.000000
25%     592.000000   592.000000   592.000000   592.000000   592.000000
50%     817.000000   822.000000   826.000000   831.000000   836.000000
75%    1160.000000  1170.000000  1170.000000  1170.000000  1170.000000
max    3840.000000  3840.000000  3840.000000  3840.000000  3840.000000
```

```
              1805         1806         1807         1808         1809  …  \
count   193.000000   193.000000   193.000000   193.000000   193.000000  …
mean    982.502591   982.829016   985.419689   980.937824   982.393782  …
std     584.043985   584.097850   590.514505   578.200194   581.878397  …
min     249.000000   248.000000   248.000000   248.000000   248.000000  …
25%     593.000000   593.000000   593.000000   593.000000   593.000000  …
50%     836.000000   836.000000   836.000000   836.000000   836.000000  …
75%    1170.000000  1170.000000  1170.000000  1160.000000  1170.000000  …
max    3840.000000  3840.000000  3840.000000  3840.000000  3840.000000  …

                2031           2032           2033           2034  \
count     193.000000     193.000000     193.000000     193.000000
mean    23142.378238   23613.119171   24083.461140   24577.430052
std     23670.673835   24162.379036   24635.072766   25136.440969
min       557.000000     566.000000     577.000000     588.000000
25%      5180.000000    5280.000000    5380.000000    5490.000000
50%     15400.000000   15700.000000   16000.000000   16400.000000
75%     34200.000000   34800.000000   35500.000000   36200.000000
max    149000.000000  153000.000000  156000.000000  159000.000000

                2035           2036           2037           2038  \
count     193.000000     193.000000     193.000000     193.000000
mean    25077.678756   25576.476684   26107.564767   26635.953368
std     25646.475260   26138.360102   26707.571366   27233.418469
min       600.000000     612.000000     625.000000     637.000000
25%      5600.000000    5710.000000    5830.000000    5950.000000
50%     16700.000000   17000.000000   17400.000000   17700.000000
75%     37000.000000   37700.000000   38500.000000   39300.000000
max    162000.000000  165000.000000  169000.000000  172000.000000

                2039           2040
count     193.000000     193.000000
mean    27180.512953   27730.725389
std     27813.430077   28356.570830
min       650.000000     664.000000
25%      6070.000000    6190.000000
50%     18100.000000   18500.000000
75%     40100.000000   40900.000000
max    176000.000000  179000.000000

[8 rows x 241 columns]
```

[112]:
```
income_df.fillna(income_df.mean(), inplace=True)
```

Now all missing values will be replaced by the mean.

[113]:
```
income_df.head()
```

[113]:
```
       country  1800  1801  1802  1803  1804  1805  1806  1807  1808  … \
0  Afghanistan   603   603   603   603   603   603   603   603   603  …
1      Albania   667   667   667   667   667   668   668   668   668  …
2      Algeria   715   716   717   718   719   720   721   722   723  …
3      Andorra  1200  1200  1200  1200  1210  1210  1210  1210  1220  …
4       Angola   618   620   623   626   628   631   634   637   640  …

    2031   2032   2033   2034   2035   2036   2037   2038   2039   2040
0   2550   2600   2660   2710   2770   2820   2880   2940   3000   3060
1  19400  19800  20200  20600  21000  21500  21900  22300  22800  23300
2  14300  14600  14900  15200  15500  15800  16100  16500  16800  17100
3  73600  75100  76700  78300  79900  81500  83100  84800  86500  88300
4   6110   6230   6350   6480   6610   6750   6880   7020   7170   7310

[5 rows x 242 columns]
```

[114]:
```
children_df.head()
```

[114]:
```
               country  1800  1801  1802  1803  1804  1805  1806  1807  1808  \
0          Afghanistan  7.00  7.00  7.00  7.00  7.00  7.00  7.00  7.00  7.00
1              Albania  4.60  4.60  4.60  4.60  4.60  4.60  4.60  4.60  4.60
2              Algeria  6.99  6.99  6.99  6.99  6.99  6.99  6.99  6.99  6.99
3               Angola  6.93  6.93  6.93  6.93  6.93  6.93  6.93  6.94  6.94
4  Antigua and Barbuda  5.00  5.00  4.99  4.99  4.99  4.98  4.98  4.97  4.97

   …  2091  2092  2093  2094  2095  2096  2097  2098  2099  2100
0  …  1.74  1.74  1.74  1.74  1.74  1.74  1.74  1.74  1.74  1.74
1  …  1.78  1.78  1.78  1.79  1.79  1.79  1.79  1.79  1.79  1.79
2  …  1.86  1.86  1.86  1.86  1.86  1.86  1.86  1.86  1.86  1.86
3  …  2.54  2.52  2.50  2.48  2.47  2.45  2.43  2.42  2.40  2.40
4  …  1.81  1.81  1.81  1.81  1.81  1.81  1.81  1.82  1.82  1.82

[5 rows x 302 columns]
```

We printed the first 5 lines of the third dataframe.

[115]:
```
children_df.describe()
```

[115]:
```
             1800        1801        1802        1803        1804        1805  \
count  184.000000  184.000000  184.000000  184.000000  184.000000  184.000000
mean     6.110707    6.107663    6.111033    6.110054    6.110435    6.110217
std      0.791456    0.795118    0.789068    0.788346    0.788456    0.784976
min      4.040000    4.040000    3.910000    4.050000    3.940000    4.060000
25%      5.670000    5.670000    5.670000    5.670000    5.670000    5.670000
50%      6.190000    6.190000    6.190000    6.190000    6.190000    6.190000
75%      6.717500    6.717500    6.717500    6.717500    6.717500    6.717500
max      8.100000    8.100000    8.100000    8.100000    8.100000    8.100000
```

```
             1806        1807        1808        1809  …         2091  \
count  184.000000  184.000000  184.000000  184.000000  …  184.000000
mean     6.105815    6.104511    6.096359    6.084457  …    1.894239
std      0.790403    0.791440    0.806280    0.834796  …    0.196231
min      4.070000    4.050000    4.000000    3.210000  …    1.440000
25%      5.670000    5.670000    5.670000    5.670000  …    1.770000
50%      6.190000    6.180000    6.160000    6.160000  …    1.810000
75%      6.717500    6.717500    6.717500    6.717500  …    1.930000
max      8.100000    8.100000    8.100000    8.100000  …    2.630000

             2092        2093        2094        2095        2096        2097  \
count  184.000000  184.000000  184.000000  184.000000  184.000000  184.000000
mean     1.890870    1.888098    1.885707    1.882935    1.880380    1.878261
std      0.190281    0.184809    0.179226    0.173738    0.168261    0.163354
min      1.440000    1.450000    1.450000    1.450000    1.450000    1.450000
25%      1.780000    1.780000    1.780000    1.780000    1.780000    1.780000
50%      1.810000    1.810000    1.810000    1.810000    1.810000    1.810000
75%      1.930000    1.922500    1.922500    1.922500    1.920000    1.920000
max      2.600000    2.580000    2.550000    2.530000    2.510000    2.500000

             2098        2099        2100
count  184.000000  184.000000  184.000000
mean     1.876033    1.873478    1.873478
std      0.158414    0.153074    0.153074
min      1.450000    1.450000    1.450000
25%      1.780000    1.780000    1.780000
50%      1.810000    1.810000    1.810000
75%      1.912500    1.910000    1.910000
max      2.480000    2.460000    2.460000

[8 rows x 301 columns]
```

[116]:
```
children_df.fillna(children_df.mean(), inplace=True)
```

Missing values are replaced by the mean.

[117]:
```
years = pd.Series(range(1800,2040)).astype(str)
lifeex_df1 = pd.melt(lifeex_df,id_vars=['country'],value_vars = years,␣
 ↪var_name='Year',value_name='life_expectancy_years')
lifeex_df1.describe()
```

[117]:
```
       life_expectancy_years
count           44880.000000
mean               45.869520
std                18.110957
min                 1.010000
25%                31.500000
50%                36.600000
```

```
75%                 63.100000
max                 87.600000
```

[118]:
```
income_df1 = pd.melt(income_df,id_vars=['country'],value_vars = years,␣
↪var_name='Year',value_name='income_per_person_gdppercapita_ppp_inflation_adjusted')
```

[119]:
```
children_df1 = pd.melt(children_df,id_vars=['country'],value_vars = years,␣
↪var_name='Year',value_name='children_per_woman_total_fertility')
```

[120]:
```
income_df1.describe()
```

[120]:
```
       income_per_person_gdppercapita_ppp_inflation_adjusted
count                                       46320.000000
mean                                         6339.871611
std                                         13183.875469
min                                           245.000000
25%                                           896.000000
50%                                          1740.000000
75%                                          4762.500000
max                                        179000.000000
```

[121]:
```
children_df1.describe()
```

[121]:
```
       children_per_woman_total_fertility
count                        44160.000000
mean                             5.143811
std                              1.793541
min                              1.120000
25%                              3.910000
50%                              5.770000
75%                              6.550000
max                              8.870000
```

Since we have 3 dataframes we will first melt each dataframe.

[122]:
```
lifeincome_df = pd.merge(lifeex_df1, income_df1, how='left',␣
↪left_on=['country', 'Year'], right_on = ['country', 'Year'] )
lifeincome_df.head()
```

[122]:
```
       country  Year  life_expectancy_years  \
0  Afghanistan  1800                28.200000
1      Albania  1800                35.400000
2      Algeria  1800                28.800000
3      Andorra  1800                31.502717
4       Angola  1800                27.000000

   income_per_person_gdppercapita_ppp_inflation_adjusted
0                                                603
```

```
1                                                    667
2                                                    715
3                                                   1200
4                                                    618
```

[123]:
```
all_df = pd.merge(lifeincome_df, children_df1, how='left', left_on=['country',␣
↪'Year'], right_on = ['country', 'Year'] )
all_df.head()
```

[123]:
```
       country  Year  life_expectancy_years  \
0  Afghanistan  1800                28.200000
1      Albania  1800                35.400000
2      Algeria  1800                28.800000
3      Andorra  1800                31.502717
4       Angola  1800                27.000000

   income_per_person_gdppercapita_ppp_inflation_adjusted  \
0                                                603
1                                                667
2                                                715
3                                               1200
4                                                618

   children_per_woman_total_fertility
0                                7.00
1                                4.60
2                                6.99
3                                 NaN
4                                6.93
```

Now we merged all the dataframes into one dataframe.

[124]:
```
all_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 44880 entries, 0 to 44879
Data columns (total 5 columns):
 #   Column                                                Non-Null Count
Dtype
---  ------                                                --------------
-----
 0   country                                               44880 non-null
object
 1   Year                                                  44880 non-null
object
 2   life_expectancy_years                                 44880 non-null
float64
 3   income_per_person_gdppercapita_ppp_inflation_adjusted  44880 non-null
```

```
int64
 4   children_per_woman_total_fertility                    44160 non-null
float64
dtypes: float64(2), int64(1), object(2)
memory usage: 2.1+ MB
```

[125]:
```
all_df.describe()
```

[125]:
```
       life_expectancy_years  \
count           44880.000000
mean               45.869520
std                18.110957
min                 1.010000
25%                31.500000
50%                36.600000
75%                63.100000
max                87.600000

       income_per_person_gdppercapita_ppp_inflation_adjusted  \
count                                       44880.000000
mean                                         6196.456863
std                                         12990.642538
min                                           245.000000
25%                                           891.000000
50%                                          1720.000000
75%                                          4660.000000
max                                        179000.000000

       children_per_woman_total_fertility
count                        44160.000000
mean                             5.143811
std                              1.793541
min                              1.120000
25%                              3.910000
50%                              5.770000
75%                              6.550000
max                              8.870000
```

[126]:
```
all_df.groupby('country').mean()
```

[126]:
```
             life_expectancy_years  \
country
Afghanistan              37.825708
Albania                  49.800417
Algeria                  44.300000
Andorra                  48.520956
Angola                   37.713750
…                              …
```

```
Venezuela                47.310833
Vietnam                  44.845000
Yemen                    35.592500
Zambia                   41.567083
Zimbabwe                 42.710417

             income_per_person_gdppercapita_ppp_inflation_adjusted  \
country
Afghanistan                                          1408.962500
Albania                                              3672.900000
Algeria                                              5077.112500
Andorra                                             16307.333333
Angola                                               2560.570833
…                                                           …
Venezuela                                            6702.375000
Vietnam                                              2114.416667
Yemen                                                1801.816667
Zambia                                               1669.554167
Zimbabwe                                             1464.091667

             children_per_woman_total_fertility
country
Afghanistan                            6.716625
Albania                                4.069833
Algeria                                6.143833
Andorra                                     NaN
Angola                                 6.807000
…                                         …
Venezuela                              4.999250
Vietnam                                4.306542
Yemen                                  6.626292
Zambia                                 6.438042
Zimbabwe                               6.147542

[187 rows x 3 columns]
```

Exploratory Data Analysis

> **Tip**: Now that you've trimmed and cleaned your data, you're ready to move on to exploration. Compute statistics and create visualizations with the goal of addressing the research questions that you posed in the Introduction section. It is recommended that you be systematic with your approach. Look at one variable at a time, and then follow it up by looking at relationships between variables.

1.2.2 Research Question 1 What are the effects of income on life expectancy and children per woman?

This analysis will look into the effects of an income have on life expectancy and woman fertility. We will look at the median of the income and split the income into either low or high income.

[127]:
```
income_median = all_df['income_per_person_gdppercapita_ppp_inflation_adjusted'].
↪median()
```

[128]:
```
lowIncome = all_df.query('income_per_person_gdppercapita_ppp_inflation_adjusted␣
↪<=@income_median')
```

[129]:
```
highIncome = all_df.
↪query('income_per_person_gdppercapita_ppp_inflation_adjusted␣
↪>@income_median')
```

[130]:
```
lowIncome.mean()
```

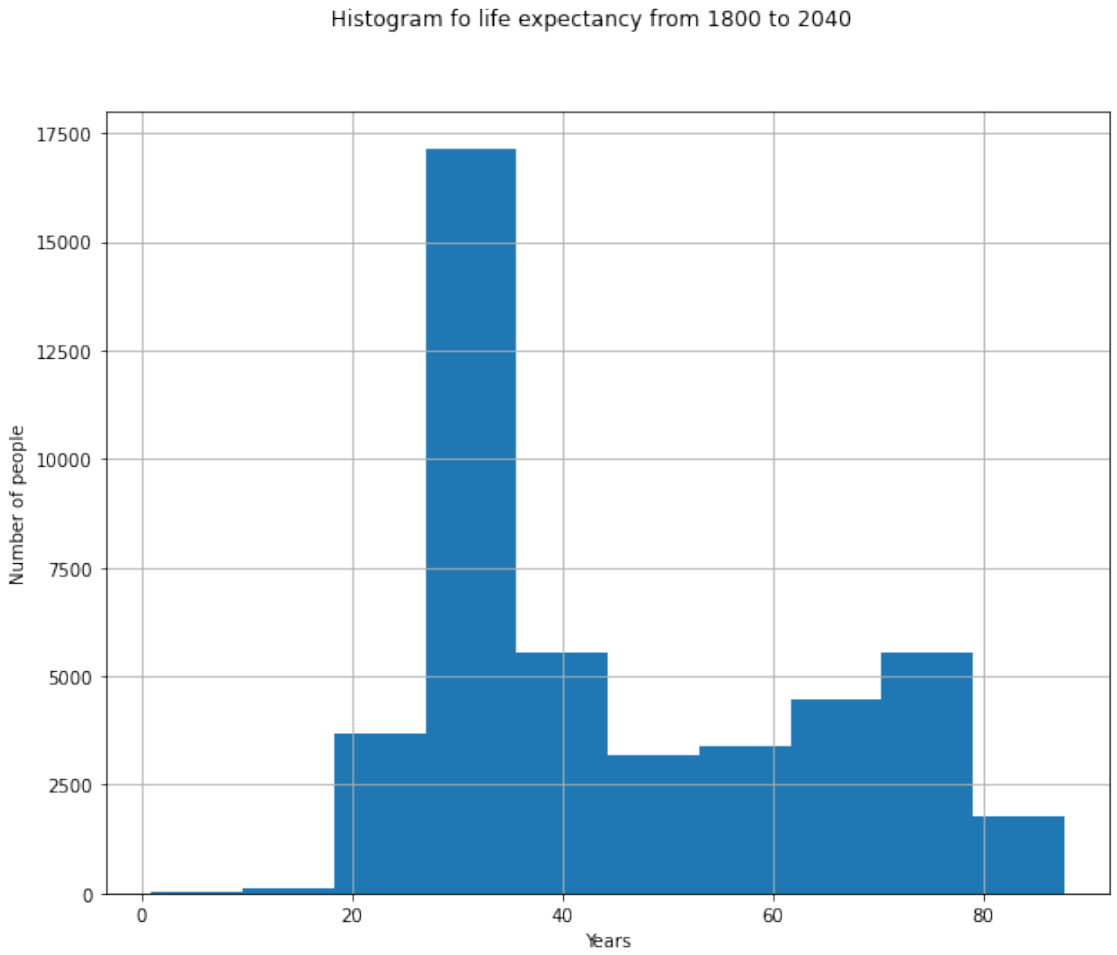
[130]:
```
Year                                                          inf
life_expectancy_years                                   33.657132
income_per_person_gdppercapita_ppp_inflation_adjusted  943.683405
children_per_woman_total_fertility                       6.192447
dtype: float64
```

[131]:
```
highIncome.mean()
```

[131]:
```
Year                                                          inf
life_expectancy_years                                5.810806e+01
income_per_person_gdppercapita_ppp_inflation_adjusted  1.146048e+04
children_per_woman_total_fertility                   4.093274e+00
dtype: float64
```

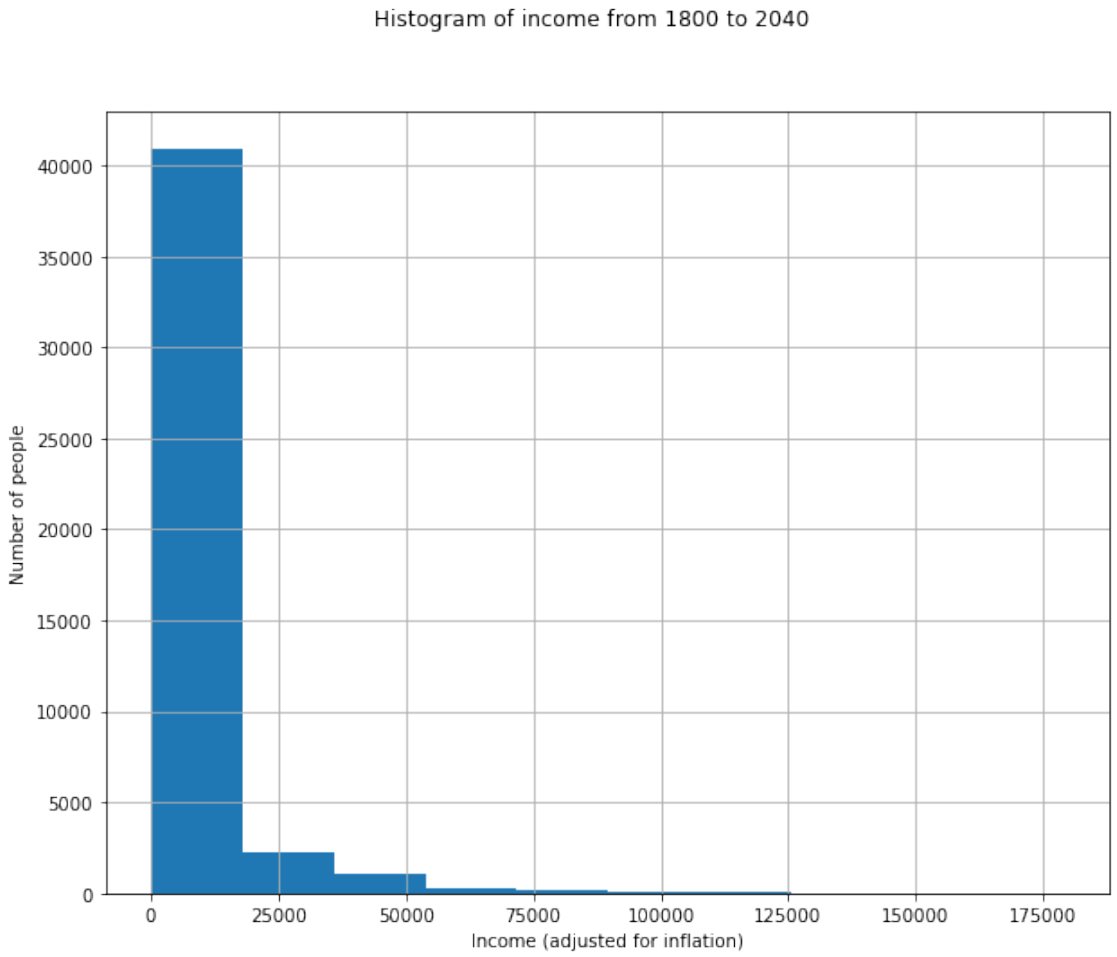
[132]:
```
viz1 = all_df['life_expectancy_years'].hist(figsize=(10,8))
plt.suptitle("Histogram fo life expectancy from 1800 to 2040")
viz1.set_xlabel("Years")
viz1.set_ylabel("Number of people")
```

[132]:
```
Text(0, 0.5, 'Number of people')
```



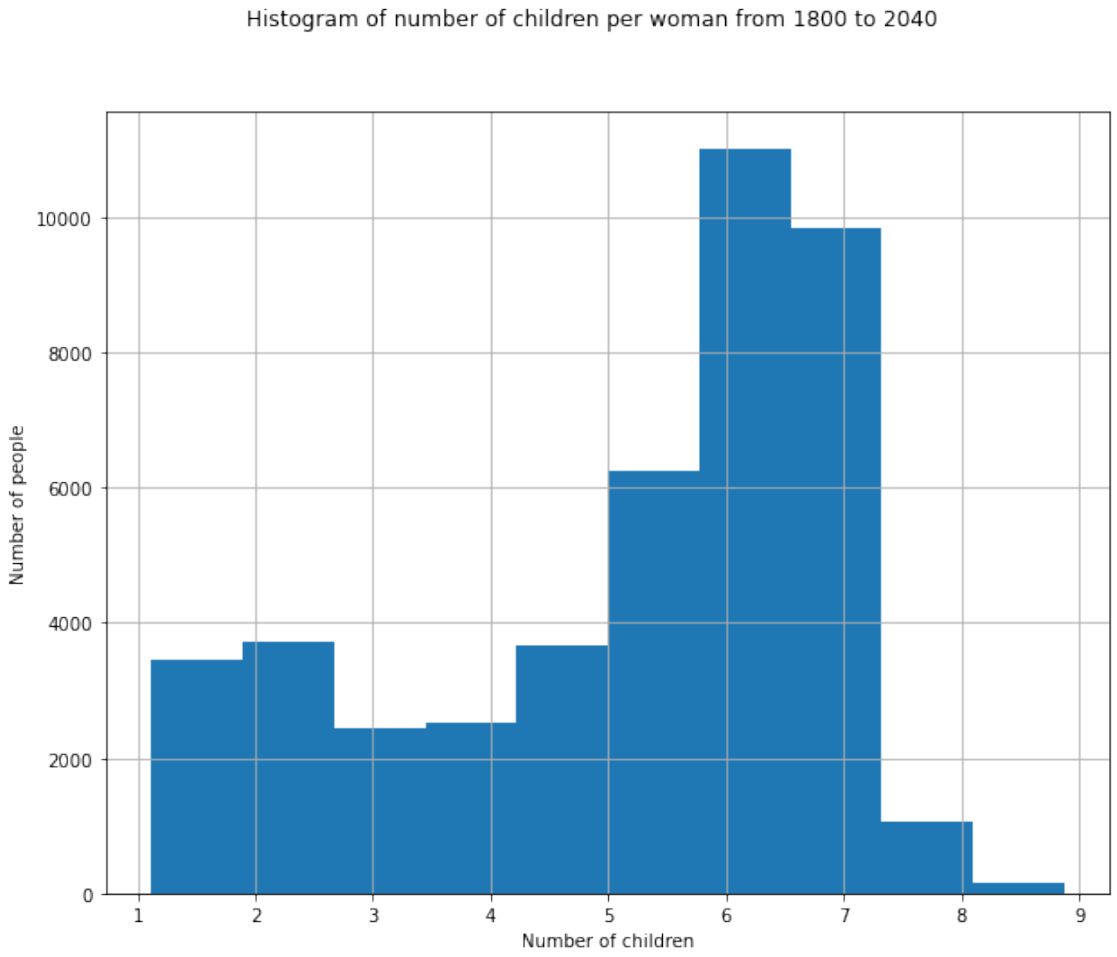
[133]:
```
viz1 = all_df['income_per_person_gdppercapita_ppp_inflation_adjusted'].
 ↪hist(figsize=(10,8))
plt.suptitle("Histogram of income from 1800 to 2040")
viz1.set_xlabel("Income (adjusted for inflation)")
viz1.set_ylabel("Number of people")
```

[133]:
```
Text(0, 0.5, 'Number of people')
```



[134]:
```
viz1 = all_df['children_per_woman_total_fertility'].hist(figsize=(10,8))
plt.suptitle("Histogram of number of children per woman from 1800 to 2040")
viz1.set_xlabel("Number of children")
viz1.set_ylabel("Number of people")
```

[134]:
```
Text(0, 0.5, 'Number of people')
```



The is a histogram of all 3 indicators from the year 1800 to 2040

Effects on Income

The results show that people with low income have a median life expectancy of 33 years. While high income people have a median of 53 years.

Also we can see that the income does have an effect on children per woman. People with high income have 4-5 children, but low income people have 6 children.

So there is a correlation between income and both life expectancy and number of children per woman.

1.2.3 Research Question 2 How has income, life expectancy, and children per woman changes throught the years?

This analysis will look at the trends of income, Life Expectancy, and Women Fertility across time. This analysis will go from the year 1800 to 2040 and display the trends.

[135]:
```
acrossYears_df = all_df.groupby('Year', as_index= False).mean()
```

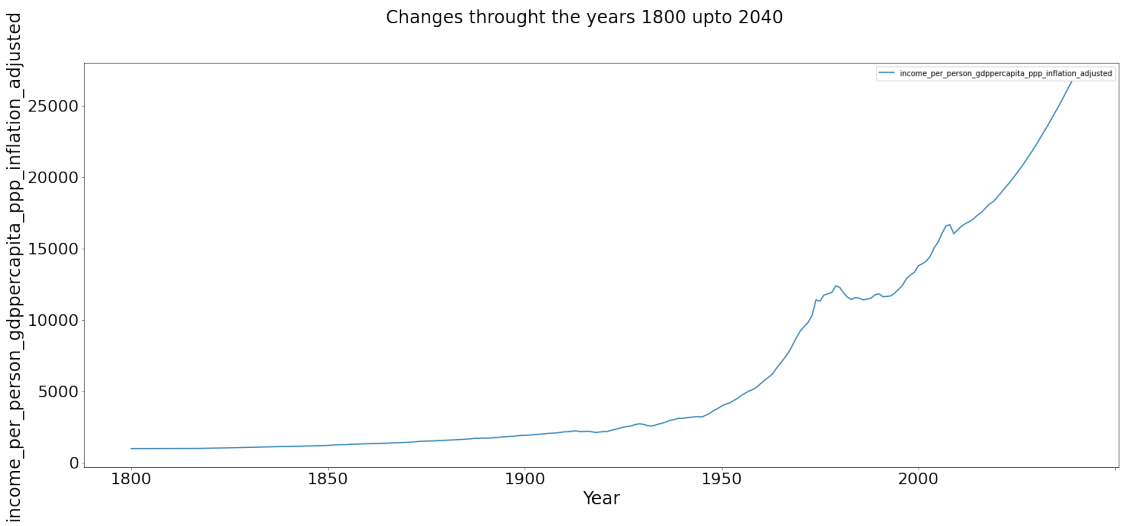
[136]:
```
acrossYears_df.head()
```

[136]:
```
   Year  life_expectancy_years  \
0  1800              31.502717
1  1801              31.461957
2  1802              31.478804
3  1803              31.383152
4  1804              31.459239

   income_per_person_gdppercapita_ppp_inflation_adjusted  \
0                                         974.508021
1                                         974.893048
2                                         976.673797
3                                         976.823529
4                                         977.844920

   children_per_woman_total_fertility
0                            6.110707
1                            6.107663
2                            6.111033
3                            6.110054
4                            6.110435
```

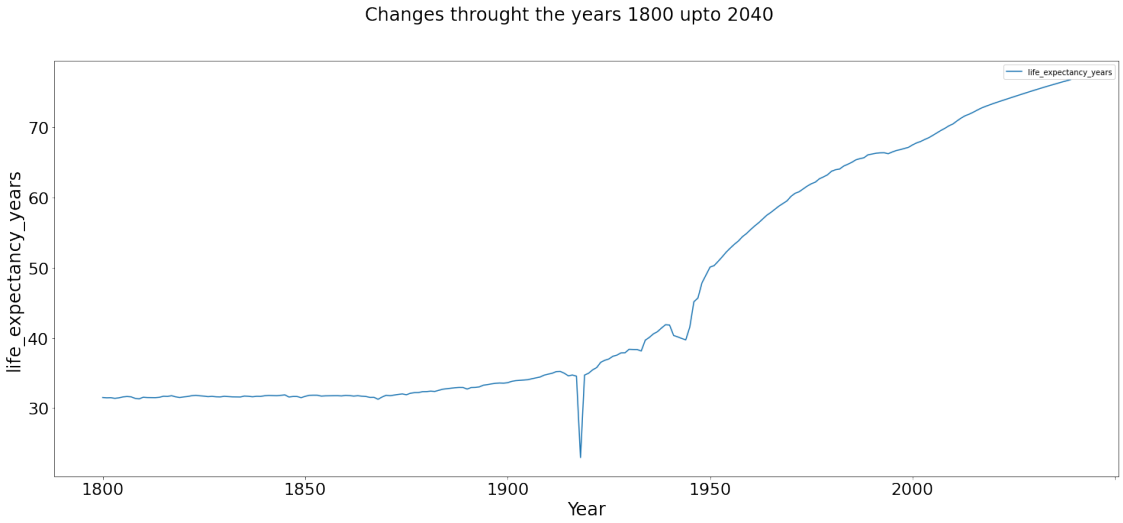
[137]:
```
graph_df = all_df.groupby('Year', as_index= False).mean()
def graphPlot(graph_df, xax,yax):
    graph_df = all_df.groupby('Year', as_index= False).mean()
    graph_df.plot(x = xax ,  y = yax, visible=True, figsize=(25,10))
    plt.suptitle('Changes throught the years 1800 upto 2040', fontsize=24)
    plt.xlabel(xax, fontsize=24)
    plt.ylabel(yax, fontsize=24)
    plt.xticks(fontsize=22)
    plt.yticks(fontsize=22)
    x_axis = pd.Series(range(1800,2040)).astype(str)
```

The function graphPlot will help us plot graphs using only 3 arguments this allows us to avoid repetitive code.

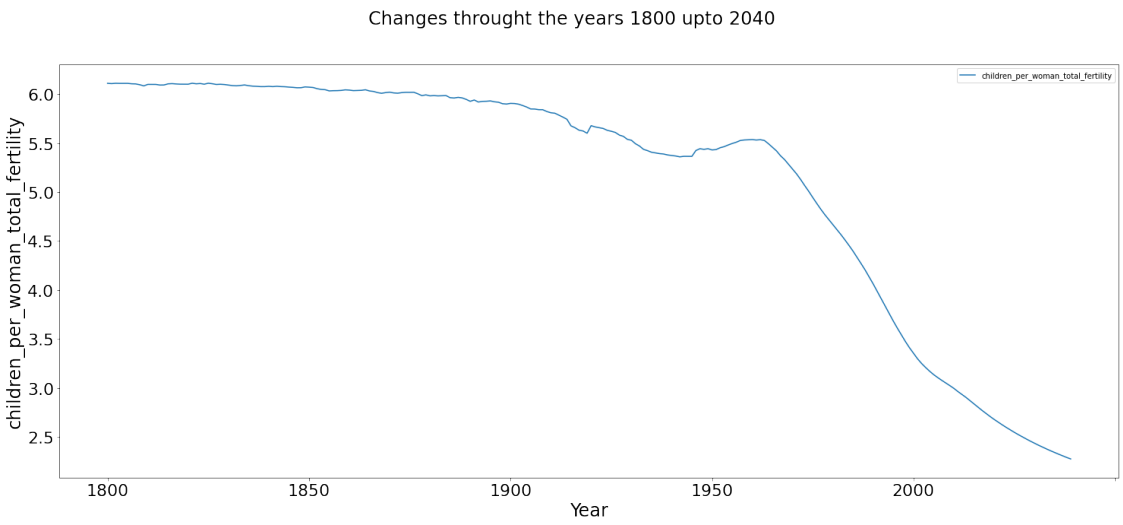
[138]:
```
graphPlot(acrossYears_df,'Year',␣
↪'income_per_person_gdppercapita_ppp_inflation_adjusted')
```



[139]:
```
graphPlot(acrossYears_df,'Year', 'life_expectancy_years')
```



[140]:
```
graphPlot(acrossYears_df,'Year', 'children_per_woman_total_fertility')
```



Trends from 1800 to 2040 As shown in the graph the income and life expectancy is increasing but the rate of women having children is decreasing. This might be due to the fact that more woman are entering the workforce thorught the years and have little time to have children but more data is required to prove this idea.

Conclusions

This report uses 3 indicatores which are income, life expectancy, and children per woman to investigate trends between the selected metrics. The analysis tackled 2 Questions.

Question 1: What are the effects of income on life expectancy and children per woman?

Question 2: How has income, life expectancy, and children per woman changes throught the years?

This analysis shows that globally people are living longer and are earning more and this trend has been consistent through the 220 years of recoreded data. Furthermore there is a strong correlation between income, life expectancy and children per woman.

The size of the data is enough as it covers 187 countries from the year 1800 to 2040 but since the data for the income and life expectancy isn't specific to females this does pose a data limitation for the analysis.